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Renewable Energy Question 19: How has Michigan, and how have other jurisdictions, applied energy mandates in situations where an existing provider has excess capacity prior to the mandate?

Although this question is in the section concerning renewable energy, it is worded as potentially applying to the Renewable Portfolio Standard, Energy Optimization Standard, and perhaps the authorization of Retail Competition. As such, this response addressed the issue of over-capacity in consideration of all three policies.

In sum, over-capacity is only a problem for utilities when they own and operate relatively expensive or inefficient generating resources. Because of the prevalence of regional electricity generation and capacity markets, such as those run by the Midwest Independent System Operator (MISO) and the PJM Interconnection (PJM), markets are readily available for any excess capacity that a utility may have above the load it is obligated to serve. However, these excess generating resources must be economically competitive with other available resources. If not, then free market principles dictate that more expensive resources should be idled temporarily or retired permanently.

Energy mandates, whether renewable energy standards, energy efficiency standards or retail competition policies, impact electricity markets to the benefit of consumers by reducing the price of electricity by bringing cheaper resources into the market and increasing competition, reducing the overall cost of electricity through reduced demand from energy efficiency programs, and reducing the environmental and public health costs of meeting demand for electricity. But energy mandates also tend to make it more difficult for less efficient and more expensive resources to remain profitable. In electricity markets today and the foreseeable future, coal-fired generation is a low-efficiency, high-cost resource, and because of Michigan's historical over-reliance on coal-fired generation, Michigan utilities are exposed to these market forces.

However, these market forces are neither new nor unforeseen. The retirement of a significant portion the nation's aging coal-fired generation fleet has been looming for a decade or more. The 21st Century Energy Plan prepared by the Michigan Public Service Commission in 2007 (which can be downloaded from http://www.dleg.state.mi.us/mpsc/electric/capacity/energyplan/index.htm) with participation by Michigan utilities included a list of older power plants in Michigan with projected retirement dates, based on age and inefficiency. The plants projected for retirement in 2015 or earlier had 430 megawatts generating capacity. Plants projected for retirement between 2016 and 2020 totaled 1424 megawatts generating capacity. Plants projected for retirement between 2021 and 2025 totaled another 1901 megawatts. These forecasts were made before EPA regulations were expected to require substantial pollution control investments if these plants are to continue operating after approximately 2017. Consumers Energy has already announced intent to close seven of these units by 2016, totaling 923 megawatts capacity, and to replace some of that capacity with a new combined cycle natural gas plant with 750 megawatts capacity. DTE Energy has announced only one plant closing, Harbor Beach, with capacity of 121 megawatts. The City of Detroit has closed its 86 megawatt Mistersky plant.

Additional retirements are likely over the next several years dueto economic forces regardless of Michigan's energy policies. Given the limited life of these plants without substantial reinvestment, some of these retirements should be accelerated rather than making additional pollution control investments for a short remaining life. The Union of Concerned Scientists performed just such an analysis in 2012, reported as "Ripe for Retirement" (http://www.ucsusa.org/assets/documents/clean_energy/Ripe-for-Retirement-Michigan-Report.pdf) using methods they applied uniformly across the United States. They estimated the coal plant capacity that would be uneconomic to maintain given required pollution control costs as compared to using existing and new natural gas plants under different natural gas price scenarios and identified 1,190 MW to 3,532 MW of coal plant capacity that is "ripe for retirement" because the alternatives would be cheaper.

New capacity to replace retiring capacity must generally be built before the old capacity can actually be retired. As is the case in several states that have passed renewable energy and energy efficiency standards in recent years, Michigan's Energy Optimization Standard and Renewable Portfolio Standard should be viewed as preparation for plant retirements that would have occurred anyway and therefore as reducing the amount of new fossil-fueled (presumably natural gas) capacity that will need to be constructed as replacement or the level of dependence on (sometimes volatile) regional markets to meet electricity demand.

In order to understand the significance of the existing excess capacity in Michigan, it is important to understand accurately why we currently have excess capacity.

Electricity providers manage generation to meet electricity load on a moment-to-moment basis by using the power that is cheapest to generate given their current generate assets and various constraints such as how quickly plants can be turned up or down, capacity of transmission lines, etc.. The ranking of generation plants by their variable costs is commonly referred to as "merit order". Although details of various generating plants matter, merit order is generally determined by generation plant technology. Generation that doesn't use fuel generally has negligible variable costs, so conventional hydropower, solar, and wind appear ahead of other technologies in merit order. Nuclear generation has a modest fuel cost, so would appear next in the merit order, except that nuclear plants can't be turned on and off quickly so nuclear plants are sometimes placed ahead of fuel-less renewables in merit order. Fuel-based generation follows in merit order with the ranking of individual generation plants depending on the price of fuel and the efficiency with which that fuel can be converted to electricity. Some utilities have fuel sources that are very cheap, such as municipal solid waste, petroleum coke, and natural gas liquids in excess of processing capabilities; these plants are generally dispatched ahead of coal or natural gas plants. In most places and times, coal generation has lower variable costs than natural gas, so coal plants are dispatched earlier in the merit order sequence than natural gas plants; in recent years when natural gas prices have been unusually low, natural gas plants are more and more often being dispatched ahead of coal plants. Historically, petroleum fuels were also used for electric power generation and were cost competitive with coal or natural gas; this has not generally been the case for some years, so petroleum fuels have been mostly phased out except in a few “peaking” plants that are rarely used.

Pumped Storage hydropower like the Ludington Pumped Storage Plant uses power when the marginal plants in the merit order have low variable costs (currently mostly at night) and generates when marginal plants are expensive (currently mostly mid-day and afternoon). The price differential between pumping and generation times makes pumped storage plants profitable, despite a net loss of energy in the process.

Modern electricity providers are interconnected by the transmission grid to enable them to purchase power from one another rather than each entirely meeting their own needs. Use of transmission and wholesale purchases between utilities enables them to reliably meet their load requirements with less aggregate capacity and lower variable costs by dispatching between utilities. Most electricity providers in Michigan participate in the wholesale electricity market operated by the Midwest Independent System Operator (MISO). Indiana-Michigan Electric Company participates in the wholesale market operated by the PJM Independent System Operator and a few small utilities use bilateral agreements rather than participate in the regional markets. Thus for most Michigan utilities, MISO dispatches plants in its region to meet the load in each utility’s region at the lowest total variable cost, subject to transmission constraints. Thus, power plants in Michigan are effectively competing with power plants in other states in the region to determine which will operate at any given time.

The following table provides an understanding of the dynamics of Michigan’s electricity generation in light of merit order generation and interstate wholesale market competition.

	Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Sparkline Graph	Change 2012-2001	2012-2001 as % of 2001	2012-2001 as % of 2001 Sales
A	Electricity Retail Sales	102,409	104,714	108,877	106,606	110,445	108,018	109,297	105,781	98,121	103,649	105,054	104,079		1,670	1.6%	1.6%
B	Pumped Storage Net Power Used	1,127	1,036	1,017	1,113	1,106	1,039	1,129	916	857	1,023	945	773		(354)	-31.4%	-0.3%
C	Net Load (A+B)	103,536	105,750	109,894	107,719	111,551	109,057	110,426	106,697	98,978	104,672	105,999	104,852		1,316	1.3%	1.3%
D	Conventional Hydropower	1,536	1,640	1,310	1,509	1,433	1,488	1,244	1,339	1,347	1,222	1,328	1,279		(257)	-16.7%	-0.3%
E	Other Renewables Generation	1,739	1,610	1,608	1,644	1,631	1,648	1,573	1,759	1,851	1,985	2,121	2,724		985	56.6%	1.0%
F	Nuclear Generation	26,711	31,087	27,954	30,562	32,872	29,066	31,517	31,484	21,851	29,625	32,889	28,020		1,309	4.9%	1.3%
G	Non-fossil-fuel Generation (D+E+F)	29,986	34,337	30,872	33,715	35,936	32,202	34,334	34,582	25,049	32,832	36,338	32,023		2,037	6.8%	2.0%
H	Miscellaneous Fossil Generation	740	1,101	889	1,325	1,227	683	810	621	495	565	510	530		(210)	-28.4%	-0.2%
I	Load for Coal or Natural Gas Generation (C-G-H)	72,810	70,312	78,133	72,679	74,388	76,172	75,282	71,494	73,434	71,275	69,151	72,299		(511)	-0.7%	-0.5%
J	Coal Generation	67,343	65,649	66,869	67,749	69,634	67,104	69,944	68,838	66,251	65,137	58,501	53,053		(14,290)	-21.2%	-14.0%
K	Natural Gas Generation	12,885	15,387	11,043	14,228	13,455	11,190	13,009	9,499	8,302	12,012	12,554	21,588		8,703	67.5%	8.5%
L	Coal and Natural Gas Generation (J+K)	80,228	81,036	77,912	81,977	83,089	78,294	82,953	78,337	74,553	77,149	71,055	74,641		(5,587)	-7.0%	-5.5%
M	Coal and Natural Gas Generation for Export (L-I)	7,418	10,724	(221)	9,298	8,701	2,122	7,671	6,843	1,119	5,874	1,904	2,342		(5,076)	-68.4%	-5.0%

Table RE-19-A. All quantities are millions of kilowatt-hours (or thousands of megawatt-hours). Highlighted data were obtained from the Energy Information Administration Electricity Data Browser http://www.eia.gov/electricity/data/browser/ as of 13 April 2013. Other quantities were computed as indicated in row and column labels. Sparkline graphs illustrating the data trend in each row were created in Microsoft Excel 2010.

Row A of Table RE-19-A presents retail sales by electricity providers to customers in Michigan. Retail sales include those to residential, commercial, industrial, and other end-use utility customers but exclude sales between utility companies. Retail sales by alternative electricity suppliers in the retail choice market are included. Annual sales fluctuated with weather and economic conditions but increased by a total of about 1.6% over the twelve-year period from 2001 to 2012. Michigan's Energy Optimization requirement that electricity providers assist their customers to reduce electricity consumption, which essentially took effect in 2010, has not prevented some growth in sales.

Row B of Table RE-19-A presents the net losses of electricity from operation of pumped storage plants in Michigan. Operations of the Ludington Pumped Storage Plant declined in recent years due to a combination of market conditions reducing the net value of its operations. The 31.4% reduction in net electricity consumption by the plant from 2001 to 2012 amounted to 0.3% of 2001 electricity sales in Michigan.

Row C of Table RE-19-A presents the sum of annual retail sales (from Row A) and net losses of electricity in pumped storage operations (from Row B) and represents the total needs for electricity generation to serve Michigan-based load. This total load increased by 1.3% of 2001 sales through 2012.

Row D of Table RE-19-A presents the annual generation of electricity from conventional hydropower facilities located in Michigan. Hydropower generation is primarily responsive to weather conditions that determine stream discharge. Although the data presented here should be interpreted as annual fluctuations rather than indicative of a trend, the net reduction in conventional hydropower generation in 2012 compared to 2001 was 16.7% or 0.3% of 2001 electricity sales.

Row E of Table RE-19-A presents the annual generation of electricity from renewables other than hydropower. This category includes biomass combustion, wind, landfill gas, and other miscellaneous technologies. In Michigan in the early 2000s, this category was predominantly biomass combustion. In the later period shown here, significant wind generation and some other technologies were added in response to Michigan's Renewable Portfolio Standard. As a result, generation by Other Renewables increased by 56.6% but this only amounted to about 1% of 2001 retail sales of electricity in Michigan.

Row F of Table RE-19-A presents the annual generation of electricity from nuclear plants located in Michigan. Annual fluctuations were predominantly due to operational issues and maintenance requirements but net nuclear generation grew by 4.9% between 2001 and 2012, or about 1.3% of retail sales in 2001. This increase in nuclear generation is greater than the net increase in renewables that occurred in the same period.

Row G of Table RE-19-A presents total non-fossil-fuel generation in Michigan, summing Rows D, E, and F. In total the decline in conventional hydropower, increase in Other Renewables, and increase in Nuclear Generation netted a 6.8% increase in non-fossil-fuel generation or about 2% of 2001 retail sales.

Row H of Table RE-19-A presents Miscellaneous Fossil Fuel Generation. These amounts come from petroleum coke, petroleum fuels, and miscellaneous gases. Since these are typically used because of special circumstances, they are treated here as appearing before coal and natural gas in the utility merit order. This is not strictly true in all cases, but in view of the small amounts of such generation the overall results are unaffected. Use of these fuels has declined by 0.2% of retail sales over this period.

Row I of Table RE-19-A presents the load to be generated from coal or natural gas, computed by subtracting non-fossil-fuel generation (Row G) and generation from miscellaneous fossil-fuel generation (Row H) from the total of retail sales (Row A) and losses in pumped storage operations (Row B). When non-fossil-fuel generation capacity is available or special circumstances dictate the availability of miscellaneous, these are generally given first priority in meeting load requirements. The load to be generated from coal and natural gas declined by 0.7% from 2001 to 2012, or 0.5% of 2001 retail sales. Thus, the increase in Michigan's generation from technologies other than coal and natural gas was only slightly larger over the period from 2001 to 2012 than the increase in retail sales in that period, despite the mandates of the Energy Optimization Standard and the Renewable Portfolio Standard.

In 2012, Every state except Vermont and Washington have in-state loads exceeding generation from generation technologies other within the state other than coal and natural gas. It is therefore reasonable to interpret the interstate markets as involving the import or export of power generated from coal or natural gas.

Row J of Table RE-19-A presents electricity generation in Michigan using coal. Coal generation declined significantly in 2011 and 2012 from previous years due to loss of competitiveness with generation from natural gas. As a result, electricity generated from coal in 2012 was 21.2% less than it was in 2001, corresponding to a 14% decline from retail sales served by coal generation in 2001.

Row K of Table RE-19-A presents electricity generation in Michigan using natural gas. As the last technology in the merit order, natural gas generation fluctuated with market need until 2012 when the currently low price ratio of natural gas to coal lead to some natural gas plants superseding some coal plants in the merit order and a substantial increase in natural gas usage. Natural gas generation in 2012 was 67.5% larger in 2012 than in 2001, corresponding to 8.5% of 2001 retail sales.

Row L of Table RE-19-A presents combined electricity generation by coal and natural gas plants located in Michigan, found by summing Rows J and K. Annual electricity generation from these two fossil fuels declined by 7% from 2001 to 2012, or by 5.5% of 2001 retail sales. Note that the Michigan load that needed to be met by coal or natural gas, in Row I, only declined by 0.5% of 2001 retail sales.

Row M of Table RE-19-A presents Michigan's net exports of electricity to other jurisdictions, computed by subtracting Row I from Row L but equivalent to subtracting all in-state generation from Row C representing total load. Total exports to other jurisdictions declined by 68.4% from 2001 to 2012, or by 5% of 2001 retail sales. It is therefore clear that any increase in Michigan's excess generation capacity over the period 2001 to 2012 is due to loss of exports to other states.

Since most of Michigan's generation capacity participates in the competitive wholesale markets, it is reasonable to conclude that the decline in exports illustrated in Row M of Table RE-19-A is due to the marginal plants in Michigan being less competitive in the MISO region, and not as a result of Michigan's energy efficiency, renewable energy or customer choice policies. Reduced competitiveness for export to neighboring states could be due to a combination of factors, including reduced load in those states so that they are operating higher in the merit order of the legacy plants in their jurisdictions, increased use of renewables that rank higher in merit order than fossil-fuel plants, or greater capacity to switch to natural gas generation as relative fuel prices have changed.

Table RE-19-B, below, follows the same format and logic as Table RE-19-A, discussed above, but is for the East North Central region as specified by the Energy Information Administration. This region consists of the States of Illinois, Indiana, Michigan, Ohio, and Wisconsin and thus includes all neighboring jurisdictions to Michigan except the Province of Ontario.

As is evident from Table RE-19-B, load has grown in this region since 2001 but this growth has been approximately offset by increased generation from renewables while combined growth in renewables and nuclear generation has caused a decline in the load that needs to be met with coal and natural gas generation. Moreover, at this regional scale we can also see a decline in electricity generation from coal and natural gas that is even more rapid than the decline in load to be met with these fuels and an associated decline in net exports of power from this region. The decline in generation from coal and natural gas in the East North Central region is slower than the decline in Michigan, either as a percentage of such generation in 2001 or as a percentage of electricity sales in 2001. It is therefore apparent that the decline in fossil-fueled generation in Michigan is predominantly due to the increase in renewable and nuclear generation in the surrounding states, with a resulting decline in Michigan's electricity exports, rather than to Michigan's Energy Optimization Standard and Renewable Portfolio Standard.

It is also notable that while coal-fueled generation in the region declined approximately the same percentage as in Michigan, the regional increase in generation from natural gas was a larger percentage of retail sales than in Michigan. During the recent period when natural gas price declines have made natural gas plants more meritorious and pushed coal plants further down merit order, this also has contributed to the loss of competitiveness by Michigan generators because Michigan is home to many older, inefficient and expensive-to-operate coal plants.

	Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Sparkline Graph	Change 2012-2001	2012-2001 as % of 2001	2012-2001 as % of 2001 Sales
A	Electricity Retail Sales	557,193	564,996	565,024	571,151	592,492	579,380	597,844	586,893	546,708	577,302	577,115	572,000		14,807	2.7%	2.7%
B	Pumped Storage Net Power Used	1,127	1,036	1,017	1,113	1,106	1,039	1,129	916	857	1,023	945	773		(354)	-31.4%	-0.1%
C	Net Load (A+B)	558,320	566,032	566,041	572,264	593,598	580,419	598,973	587,809	547,565	578,325	578,060	572,773		14,453	2.6%	2.6%
D	Conventional Hydropower	4,658	4,966	4,037	4,617	4,046	4,258	3,594	3,753	3,796	4,200	4,254	4,081		(577)	-12.4%	-0.1%
E	Other Renewables Generation	2,894	2,799	2,995	3,083	2,972	3,384	3,812	6,618	8,998	12,441	15,244	18,495		15,601	539.1%	2.8%
F	Nuclear Generation	146,040	145,261	143,377	150,447	150,858	152,301	155,920	156,305	145,214	154,900	155,162	155,808		9,768	6.7%	1.8%
G	Non-fossil-fuel Generation (D+E+F)	153,592	153,026	150,409	158,147	157,876	159,943	163,326	166,676	158,008	171,541	174,660	178,384		24,792	16.1%	4.4%
H	Miscellaneous Fossil Generation	3,310	2,508	3,158	4,603	3,837	3,069	3,149	3,028	2,437	2,752	3,778	2,907		(403)	-12.2%	-0.1%
I	Load for Coal or Natural Gas Generation (C-G-H)	401,418	410,498	412,474	409,514	431,885	417,407	432,498	418,105	387,120	404,032	399,622	391,482		(9,936)	-2.5%	-1.8%
J	Coal Generation	424,791	439,095	445,150	449,108	459,078	451,510	456,905	456,001	412,245	425,653	394,593	342,140		(82,651)	-19.5%	-14.8%
K	Natural Gas Generation	20,992	30,578	20,720	22,318	31,749	25,712	33,643	23,552	25,139	35,231	45,414	79,957		58,965	280.9%	10.6%
L	Coal and Natural Gas Generation (J+K)	445,783	469,673	465,870	471,426	490,827	477,222	490,548	479,553	437,384	460,884	440,007	422,097		(23,686)	-5.3%	-4.3%
M	Coal and Natural Gas Generation for Export (L-I)	44,365	59,175	53,396	61,912	58,942	59,815	58,050	61,448	50,264	56,852	40,385	30,615		(13,750)	-31.0%	-2.5%

Table RE-19-C, below, presents the state-by-state load to be generated from coal and natural gas, equivalent to Row I in Table RE-19-A for Michigan or in Table RE-19-B for the East North Central Region. In those instances where generation in the State from Conventional Hydroelectric, Other Renewables, Nuclear, and Miscellaneous Fossil Fuels exceed the load in that State, the table shows “0” as the amount of load that needs to be met with generation from coal or natural gas and any excess generation in that State would be available for sale into other states. As with Row I in Table RE-19-A, these loads could be met by generation within the state or by purchases of electricity from plants in other nearby states. The final column to the right presents the change per year in load to be met by coal and natural gas generation as a % of 2001.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012		Change 2012-2001	2012-2001 as % of 2001	Average Change per Year
United States Total	2,249,889	2,285,653	2,292,663	2,323,313	2,435,031	2,466,550	2,572,240	2,530,493	2,371,157	2,512,541	2,447,084	2,431,826		181,937	8.1%	0.7%
Connecticut	8,793	12,614	12,414	12,841	13,261	12,548	15,353	13,728	11,498	12,090	12,543	11,081		2,288	26.0%	2.2%
Maine	7,501	7,510	6,923	7,173	5,978	6,721	6,293	5,777	5,414	5,783	5,673	6,065		-1,436	-19.1%	-1.6%
Massachusetts	37,130	39,361	41,118	40,856	42,739	45,102	47,072	45,572	45,723	48,700	47,987	46,315		9,185	24.7%	2.1%
New Hampshire	0	0	0	0	0	0	0	0	0	0	0	9		9		
Rhode Island	7,266	7,441	7,672	7,768	8,028	7,632	7,834	7,632	7,456	7,644	7,583	7,566		300	4.1%	0.3%
Vermont	151	196	0	224	198	0	43	0	0	0	0	0		-151	-100.0%	-8.3%
New Jersey	40,659	42,226	44,295	48,593	48,720	45,897	48,610	47,074	40,358	45,474	42,415	41,831		1,172	2.9%	0.2%
New York	62,987	70,008	58,723	58,098	56,680	63,968	70,162	67,651	62,510	71,008	67,793	71,464		8,477	13.5%	1.1%
Pennsylvania	55,204	57,561	56,948	57,307	63,372	64,857	68,696	66,144	60,219	64,529	65,422	62,634		7,430	13.5%	1.1%
Illinois	41,445	46,583	39,514	45,508	50,534	47,104	48,730	46,142	37,425	43,202	39,974	37,553		-3,892	-9.4%	-0.8%
Indiana	96,697	100,452	99,541	102,132	105,819	104,860	108,625	105,911	97,003	102,196	100,512	99,568		2,871	3.0%	0.2%
Michigan	72,810	70,312	78,133	72,679	74,388	76,172	75,282	71,494	73,434	71,275	69,151	72,299		-511	-0.7%	-0.1%
Ohio	139,226	141,445	142,599	135,966	143,278	134,402	144,247	139,825	129,116	136,139	137,417	132,050		-7,176	-5.2%	-0.4%
Wisconsin	51,238	51,706	52,687	53,230	57,868	54,868	55,614	54,731	50,140	51,217	52,568	50,013		-1,225	-2.4%	-0.2%
Iowa	34,071	34,314	35,266	33,802	35,387	34,714	36,607	35,015	30,369	30,604	28,557	26,456		-7,615	-22.4%	-1.9%
Kansas	24,818	26,683	26,503	25,768	28,780	29,348	28,426	29,119	26,478	27,290	29,590	26,562		1,744	7.0%	0.6%
Minnesota	46,254	45,672	46,542	47,437	49,696	50,074	50,712	49,566	44,610	47,481	48,056	45,994		-260	-0.6%	0.0%
Missouri	63,088	64,725	63,730	64,546	71,580	71,619	74,872	72,660	66,961	74,434	72,384	69,702		6,614	10.5%	0.9%
Nebraska	14,837	14,409	16,748	14,636	17,144	17,059	16,557	18,689	18,125	16,969	19,987	21,454		6,617	44.6%	3.7%
North Dakota	8,444	8,590	8,632	8,718	9,246	9,316	9,933	9,429	8,135	6,782	5,881	6,763		-1,681	-19.9%	-1.7%
South Dakota	5,142	4,572	4,744	5,435	6,557	6,505	7,473	7,811	6,143	4,739	2,396	2,971		-2,171	-42.2%	-3.5%
Delaware	9,942	11,315	11,263	11,044	11,199	11,450	11,618	11,458	11,029	11,412	11,292	11,446		1,504	15.1%	1.3%
District of Columbia	10,757	10,867	10,872	11,379	11,590	11,315	12,035	11,779	12,164	11,677	11,432	11,250		493	4.6%	0.4%
Florida	126,710	140,756	146,616	147,638	156,510	171,350	179,153	179,616	183,932	195,525	197,098	196,862		70,152	55.4%	4.6%
Georgia	81,181	89,719	85,929	91,873	96,487	100,180	102,595	101,256	95,726	103,619	101,139	95,233		14,052	17.3%	1.4%
Maryland	42,996	51,467	50,677	45,796	47,505	45,967	47,660	45,540	45,196	48,760	45,813	45,801		2,805	6.5%	0.5%
North Carolina	78,523	79,803	73,072	80,069	82,973	82,645	88,100	86,495	80,789	89,904	85,490	84,002		5,479	7.0%	0.6%
South Carolina	23,507	22,882	22,641	25,314	24,379	27,730	26,578	27,227	21,048	27,513	25,499	24,983		1,476	6.3%	0.5%
Virginia	64,003	68,019	68,443	69,541	74,320	76,104	80,110	78,995	76,801	83,478	82,013	76,489		12,486	19.5%	1.6%
West Virginia	26,862	27,556	27,252	27,887	28,908	30,954	33,027	32,871	28,333	30,069	29,045	28,584		1,722	6.4%	0.5%
Alabama	40,163	41,969	39,091	44,311	47,021	51,218	53,081	44,298	30,254	43,843	40,422	38,259		-1,904	-4.7%	-0.4%
Kentucky	75,995	80,173	78,327	79,061	82,642	82,718	87,845	88,528	83,374	88,612	84,739	85,160		9,165	12.1%	1.0%
Mississippi	29,242	35,367	33,022	33,036	34,391	36,122	38,397	38,252	35,038	39,965	38,968	41,135		11,893	40.7%	3.4%
Tennessee	60,598	63,055	61,805	61,209	67,332	71,869	72,852	71,210	57,213	67,370	63,964	63,563		2,965	4.9%	0.4%
Arkansas	23,557	24,319	25,410	24,074	29,206	29,689	28,217	27,208	23,677	29,418	30,647	28,941		5,384	22.9%	1.9%
Louisiana	53,158	58,970	57,564	57,287	56,607	57,506	58,919	59,993	58,854	62,099	63,988	65,218		12,060	22.7%	1.9%
Oklahoma	47,176	47,487	48,464	47,371	50,216	52,545	50,139	50,091	48,274	51,216	52,720	49,595		2,419	5.1%	0.4%
Texas	274,711	279,081	281,774	272,685	287,194	290,022	288,672	285,954	279,165	286,942	301,959	290,592		15,881	5.8%	0.5%
Arizona	25,580	24,211	28,336	31,760	37,063	42,327	43,730	39,574	36,084	34,633	33,917	34,869		9,289	36.3%	3.0%
Colorado	42,501	44,533	45,016	45,259	46,108	47,023	48,214	46,800	45,891	47,768	46,007	45,494		2,993	7.0%	0.6%
Idaho	13,831	11,858	12,778	13,263	13,223	11,274	14,485	14,176	11,855	13,038	8,395	9,702		-4,129	-29.9%	-2.5%
Montana	4,336	2,775	3,700	3,640	3,465	2,823	5,174	4,314	3,509	2,670	-534	739		-3,597	-83.0%	-6.9%
Nevada	23,541	25,739	27,275	28,282	29,507	31,163	32,328	31,886	29,997	29,314	29,300	29,399		5,858	24.9%	2.1%
New Mexico	18,436	18,892	18,927	19,164	19,639	19,919	20,546	20,011	19,751	20,307	20,571	20,484		2,048	11.1%	0.9%
Utah	22,493	22,531	23,202	23,830	23,986	25,360	27,037	27,178	26,229	26,517	26,614	27,389		4,896	21.8%	1.8%
Wyoming	11,672	11,804	12,252	12,287	12,573	13,300	14,006	14,848	13,319	12,786	11,527	11,618		-54	-0.5%	0.0%
California	166,380	145,963	147,237	163,153	154,118	158,500	175,799	186,278	174,018	167,428	156,274	184,729		18,349	11.0%	0.9%
Oregon	16,681	10,180	11,078	11,830	14,295	8,908	13,528	12,472	10,731	11,207	0	929		-15,752	-94.4%	-7.9%
Washington	14,755	0	0	0	1,532	0	0	0	6,275	7,158	0	0		-14,755	-100.0%	-8.3%
Alaska	3,256	3,148	3,205	3,607	3,762	4,263	4,093	4,225	3,835	3,916	4,071	3,969		713	21.9%	1.8%
Hawaii	1,334	352	1,523	1,543	1,227	1,187	1,219	1,260	1,432	1,617	1,537	1,724		390	29.2%	2.4%

The useful life of fossil fuel plants varies somewhat as reinvestment can lengthen the life of a plant by substantial replacement of components. We can reasonably approximate the average useful life of the capital invested in coal and natural gas plants at about 40 years. It follows that plant retirements can generally be managed at a rate of about 2.5% per year, but due to a wave of retirements reflecting a wave of construction in the 1960s and 1970s the current rate of retirements is accelerated beyond 2.5% per year. Thus, as a general rule, mandates for energy efficiency and renewable energy adoption will lead to stranded assets only if they reduce the rate of growth in load for fossil-fuel generation, as computed above, below the rate of fossil fuel retirements. As can be seen in Table RE19-C, above, only the States of Vermont, South Dakota, Idaho, Montana, Oregon, and Washington have experienced such a decline in load to be met with fossil-fueled generation over the last decade. Vermont and South Dakota experienced quantitatively small declines that could be readily absorbed into the regional markets in which they are embedded; by calculations not shown here, both were net importers of fossil-fueled generation in 2001 and have effectively eliminated their imports over the last decade.

The Pacific Northwest States (Montana, Idaho, Washington, and Oregon) combined are net exporters of electricity from the combination of Conventional Hydropower, Other Renewables, and Nuclear Generation so that all of their generation from coal and natural gas can be considered as for net export to other States (predominantly California). As a group, they have reduced their total net generation from coal and natural gas at a rate consonant with the natural retirement of coal- and natural gas-fueled plants.

Review of the combined electricity efficiency and renewable generation mandates of all the states (see for example the useful compilation at http://www.dsireusa.org/) shows that none of them would require utilities to reduce coal and natural gas fueled generation at a rate that would exceed the expected long term retirement rate of aging fossil fuel resources, and most, like Michigan, would allow new capacity to be a mix of renewables and fossil fuels. Under these circumstances and with the possibility of regional markets to smooth the lumpiness of capacity when large plants are retired, any utility exercising reasonable foresight should be able to avoid excessive idle capacity and stranded costs.

The 5,587 million kilowatt-hours decline in annual combined coal and natural gas generation in Michigan during the period 2001-2012 roughly corresponds to 1 gigawatt (1,000 megawatts) of generating capacity that isn't needed but would have been required if the 2001 level of combined coal and natural gas generation had persisted in 2012. The capacity that is "ripe for retirement" substantially exceeds this amount, so Michigan's appropriate response should be for its major utilities to undertake the orderly retirement of some of these plants.